

REMARKS

I. Status of the claims

Claims 1-9 are pending. Claim 1 has been amended to clarify that the biodiesel of the invention is capable of exhibiting a NOx emission reduction value in the range of 14.4-53.3%, when compared to a diesel fuel having a NOx emission level of about 180 ppm. Support for this amendment may be found on page 11, Table 1. Claim 6 has been amended to include micro filtration as one of the additional purification steps so that the claim reciting this purification step, claim 9, has the correct dependency. Support for this amendment may be found on page 3, lines 25-28 and page 5, lines 15-19.

No new matter has been added through these amendments.

II. Rejection under 35 U.S.C. § 112, first paragraph

The examiner has rejected claims 1-9 under 35 U.S.C. § 112, first paragraph as failing to comply with the written description requirement. In particular, the examiner asserts that Applicants should amend claim 1 to recite the NOx emission reduction range of “14.4-53.3%,” because this is the range being supported in Table 1 of the specification. The examiner also states that this range is obtained when the claimed biodiesel is compared to a diesel fuel having a NOx emission level of 180 ppm; hence such limitation should be included in claim 1.

Applicants disagree that written description is lacking in claim 1. The examiner admits in the Office Action that the NOx emission reduction range of “14.4-53.3%” is supported by Table 1 of the specification. See Office Action, page 2. In fact, the claimed range of 14-53% is simply the range of 14.4 %-53.3% rounded to the nearest integral. Hence the specification supports the claimed range of 14-53%. Nonetheless, for purposes of expedited prosecution in this application, Applicants have amended claim 1 to recite the range of “14.4-53.3%.” Claim 1 has also been amended in accordance with the examiner’s suggestion to recite that the NOx emission reduction value is obtained when compared to a diesel fuel having a NOx emission level of about 180 ppm.

In view of the above amendments and remarks, Applicants respectfully request that the examiner withdraw this rejection under 35 U.S.C. § 112, first paragraph.

III. Rejection under 35 U.S.C. § 112, second paragraph

The examiner has rejected claim 9 under 35 U.S.C. § 112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. In particular, the examiner states that claim 9 refers to purification by micro filtration, while claim 6 is silent with respect to this purification step.

Applicants have amended claim 6 to include micro filtration as one of the additional purification steps. See page 3, lines 25-28 and page 5, lines 15-19 of the specification for support in adding this as a purification step. In view of this amendment, the micro filtration recited in dependent claim 9 has antecedent basis in the micro filtration step recited in claim 6. Accordingly, Applicants respectfully request that the examiner withdraw this rejection under 35 U.S.C. § 112, second paragraph.

IV. Rejections under 35 U.S.C. § 103(a)

The examiner rejected claims 1-8 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,668,439 to Billenstein et al. (“Billestein”) in view of the article entitled, “Triglycerides-based diesel fuels,” by Srivastava et al. (“Srivastava”). The examiner has also rejected claim 9 under 35 U.S.C. § 103(a) as being unpatentable over Billenstein in view of U.S. Patent No. 5,116,546 to Klok (“Klok”). Applicants respectfully traverse these rejections.

In the Office Action, the examiner admits that Billenstein does not teach the claimed process parameters with respect to time and continuous turbulent conditions. Nonetheless, the examiner asserts that the differences in the process parameters will not support patentability of the claimed subject matter. See Office Action, page 4, last paragraph. Applicants disagree with the examiner’s assertion. In fact, the distinctions of the claimed process conditions over the prior art reference are one of the main factors that enable the claimed biodiesels to produce the reduced NOx values.

One of the objectives of the invention is to improve the fuel properties of the resulting biodiesel product, for example, to reduce NOx emission. High NOx emissions are one of the drawbacks of using pure biodiesel (without blending of diesel) fuel in engines. The high NOx emissions of biodiesel are caused, at least in part, by the formation of intermediates in the product ester. The intermediates of the reaction for conversion of oil to ester are generally

mono-glycerides, di-glycerides, mono-glycerides ester, and di-glyceride ester. Each intermediate reacts with alcohol and produces ester. Nonetheless, these intermediates are in the homogeneous phase with the product ester, and the incomplete conversion of these intermediates to ester leads to high NO_x emissions. Hence it is desirable to utilize a transesterification reaction that converts oil to ester without any intermediates in the product.

Applicants have discovered the process conditions to increase the conversion from oil to ester of the transesterification reaction while decreasing intermediates in the product, which reduces NO_x values. Increased conversion is achieved in the claimed gas-liquid phase transesterification process by maintaining a continuous turbulence conditions, with a minimum reaction residence period of not less than 30 minutes. These process conditions increase the conversion to the product of mono-alkyl ester and dialkyl ester; and decrease the undesirable, unreacted intermediates of mono-, di- and tri- glycerides. The resulting biodiesel product was shown to have a reduction of NO_x emission value in the range of 14.4-53.3%, when compared to a diesel fuel having a NO_x emission level of about 180 ppm. See Table 1, on page 11 of the specification. Applicants' claimed process therefore produces an ecofriendly biodiesel product that is preferable from an environmental perspective. Such biodiesel product provides a diesel fuel substitute with many advantages. For example, the biodiesel can be used as pure biodiesel without blending of diesel and without any engine modification. The NO_x emission reduction of biodiesel product from the claimed process was also confirmed in all the engine trials and on-road trials of the corporation buses.

Billenstein, however, is completely silent relating to the fuel properties (such as NO_x emission) of biodiesel. Moreover, Billenstein does not teach or suggest the continuous turbulent conditions, which are one of the claimed process parameters to increase the conversion of the oil into ester and decrease the intermediates in the product. Rather, Billenstein's process requires a *rapid removal* of the product mixture of glycerol and fatty acid alkyl ester from the reaction zone with the steam of alcohol. See Billenstein, col. 2, lines 42-47 and col. 4, lines 23-28.

In addition to the continuous turbulent conditions, the reaction product of the claimed invention (liquid esters) is not removed from the reaction system as gas stream during the reaction and the reaction is run for a minimum reaction time of "not less than 30 minutes." These claimed process conditions are both significant to increase the conversion and decrease the

intermediates in the product, enabling the claimed biodiesels to exhibit reduced NO_x values. It is unclear how Billenstein's product, under such different reaction conditions, could reduce NO_x values in a range as Applicants claimed invention; and the examiner has not made a sufficient showing to suggest otherwise.

In addition, the claimed invention is a batch process, not a continuous counter-current process; and the claimed invention does not require the inert gas usage in the process. These conditions further distinguish Applicants' process over Billenstein's process.

Srivastava does not cure the deficiency of Billenstein. In particular, Srivastava relates to liquid-liquid phase reactions, whereby liquid oil and liquid alcohol-catalyst mixtures (below the boiling point of alcohol) are reacted under certain conditions to obtain esters (biodiesel) in liquid phase. Additionally, Srivastava teaches a temperature range that is different than that disclosed by both Applicants and Billenstein. See Srivastava, p. 126, item 6.4.1 ("The maximum yield of esters occurs at temperatures ranging from 60 to 80 °C at a molar ratio (alcohol to oil) of 6:1. Further increase in temperature is reported to have a negative effect on the conversion."). Based on these vastly different temperatures, one skilled in the art would not combine the teachings of Srivastava in the Billenstein process; hence Billenstein in view of Srivastava does not render Applicants' invention obvious.

Billenstein and Srivastava, alone or in combination, do not teach or suggest a method of using a liquid-gas phase transesterification reaction for a period of not less than 30 minutes under continuous turbulence conditions, to prepare biodiesel where the biodiesel is capable of reducing NO_x emissions in the range of 14.4-15.3 %. Klok, which has been cited by the examiner only to show the filtration techniques, fails to overcome the above-noted deficiencies of Billenstein and Srivastava. Accordingly, the claimed invention is patentable over Billenstein, Srivastava, Klok, or any combination of these references.

In view of these comments, Applicants respectfully request that the examiner withdraw the rejections under 35 U.S.C. § 103.

V. Conclusion

Applicant respectfully requests reconsideration of this application in view of the above amendment and remarks.

Except for issue fees payable under 37 C.F.R. §1.18, the Commissioner is hereby authorized by this paper to charge any additional fees during the entire pendency of this application including fees due under 37 C.F.R. §§1.16 and 1.17 which may be required, including any required extension of time fees, or credit any overpayment to Deposit Account No. 19-2380. This paragraph is intended to be a **CONSTRUCTIVE PETITION FOR EXTENSION OF TIME** in accordance with 37 C.F.R. §1.136(a)(3).

Respectfully submitted,

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